ADULT WHITE-TAILED ANTELOPE SQUIRREL (*AMMOSPERMOPHILUS LEUCURUS*) DENSITY, INDIAN WELLS VALLEY, SAN BERNARDINO COUNTY, CALIFORNIA

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ABSTRACT: We studied adult white-tailed antelope squirrels from early (March) to late (May) spring 2006 to estimate adult densities at ten locations in the Indian Wells Valley, San Bernardino County, California. We calculated early spring densities of 1.70–8.96 squirrels/ha and late spring densities of 3.06–12.81 squirrels/ha with a mean density increase of 1.39/ha between sampling periods. Adult white-tailed antelope squirrel densities (squirrels/ha) in the Indian Wells Valley, California, were 28–124 times greater than previously reported for southern Nevada. Density differences were likely due to above average precipitation and net primary production at our study site.

KeyWords: Ammospermophilus leucurus, California, density, Indian Wells Valley, White-tailed antelope squirrel

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The white-tailed antelope squirrel (*Ammospermophilus leucurus*) is a medium-sized diurnal rodent found throughout much of the western United States (Belk and Smith 1991, Hall 1981, O'Farrell and Clark 1984) including the Mojave and Colorado deserts of southeastern California below the juniper belt (Hoffmeister 1986, Jorgensen and Hayward 1965). Due to a larger relative body size than other desert rodents, the white-tailed antelope squirrel is reported to occur at low densities (Bradley 1967, Hardy 1945). Population densities of white-tailed antelope squirrels vary seasonally (Bradley 1967) and temporally (Fautin 1946, Hardy 1945), with higher densities reported in autumn (Bradley 1967) and years following population crashes (Fautin 1946, Hardy 1945). Published white-tailed antelope squirrel densities in southern Nevada ranged from 0.06/ha in spring to 0.35/ha in autumn (Bradley 1967). Chew and Butterworth (1964) reported that white-tailed antelope squirrels constituted >50% of rodent biomass in California but did not report population densities.

The objective of our study was to quantify adult white-tailed antelope squirrel population densities in early and late spring in the Indian Wells Valley, San Bernardino County, California, to our knowledge no density study for this species have been conducted in California.

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Study Area

Our study was located in the Indian Wells Valley (IWV), California, along a 15.3 km length of State Route 178 (SR 178), approximately 16 km east of Ridgecrest, and 19.3 km west of Trona, California, in response to a California Department of Transportation (Caltrans) highway improvement project. The IWV slopes generally downward from west to east, with dry washes present throughout typically oriented on a north-south axis. Climate is typical of the Mojave Desert, with low annual precipitation (12.2 cm), primarily occurring in winter and spring. Habitats were typical of the Mojave Desert floristic province consisting of Creosote Bush Scrub and Salt Bush Scrub (Sawyer et al. 2009). Total annual precipitation was above average from 2003–2005 (Figure 1, WRCC 2007).

Methods

We established ten 8.8 ha sampling grids (hereafter grids) adjacent to SR 178 in the IWV. Grids consisted of 100 Sherman live traps (traps) in a 4x25 array and baited with four-way horse feed. Grids were placed within the Caltrans right-of-way (ROW) > 20 m from the road surface, and on adjacent Bureau of Land Management (BLM) lands at locations identified by Caltrans for culvert rehabilitation and reinstallation (generally one grid every 1.5 km).

We conducted trapping in accordance with the California Department of Fish and Game (CDFG

2003) Mohave ground squirrel (*Xerospermophilus mohavensis*) survey guidelines. Each sampling session consisted of five consecutive days with trapping initiated at sunrise and terminated at sunset; or when ambient air temperatures exceeded 32º C, 30 cm above ground level, as required by CDFG (2003) guidelines. The early spring sampling was conducted between 15 March and 30 April 2006, with late spring sampling conducted from 1–30 May 2006.

Due to permitting restrictions we did not permanently mark (e.g., ear or PIT tags) white-tailed antelope squirrels during our study. Captured white-tailed squirrels were aged, sexed, and temporarily marked with a Sharpie® marker upon first capture each session. As a result of using non-permanent/non-specific individual marks during our study, we used the Schumacher-Eschmeyer closed population model (Krebs 1999) to estimate adult white-tailed antelope squirrel populations (N ± SE) and densities at each grid for early and late spring sampling sessions (Krebs 1999).

$$N_0 = \frac{\sum_{t=1}^{1} (C_t M_t)}{\sum_{t=1}^{1} R_t} \qquad SE_{N_0} = \sqrt{\frac{\sum_{i=1}^{s} R_t}{\left(\sum_{i=1}^{s} C_t M_t\right)^2}}$$

Where M_t is the number of marked individuals in the population before time t, C_t is the number of individuals at sample time t, and R_t is the number of individuals marked at time t. The 95% Confidence Interval was calculated as $1/N_0$ (df = s-1).

Results

We captured 1,166 adult white-tailed antelope squirrels from 21 March to 31 May 2006 during 10,000 trap days. We used the Schumacher-Eschmeyer closed population model to estimate white-tailed antelope squirrel population size (N ± SE) with confidence intervals (CI) at our study site.

Adult white-tailed antelope squirrel densities were estimated by dividing the Schumacher-Eschmeyer derived population estimate by 8.8 ha. Spring adult white-tailed antelope squirrel densities ranged from 1.70 – 8.96 squirrels/ha, with a mean density of 5.36 squirrels/ha. Late spring adult white-tailed antelope squirrel densities ranged from 3.06 – 12.81 squirrels/ha, with a mean density of 7.45 (Table 1).

Mean adult white-tailed antelope squirrels densities increased by 181% from early to late spring, with densities increasing at 7 of 10 grids. The greatest density increase from early to late spring was 1.70 squirrels/ha to 9.75 squirrels/ha (Grid 4), while Grid 9 had the greatest density decrease from early to late spring (8.96 squirrels/ha to 3.06 squirrels/ha).

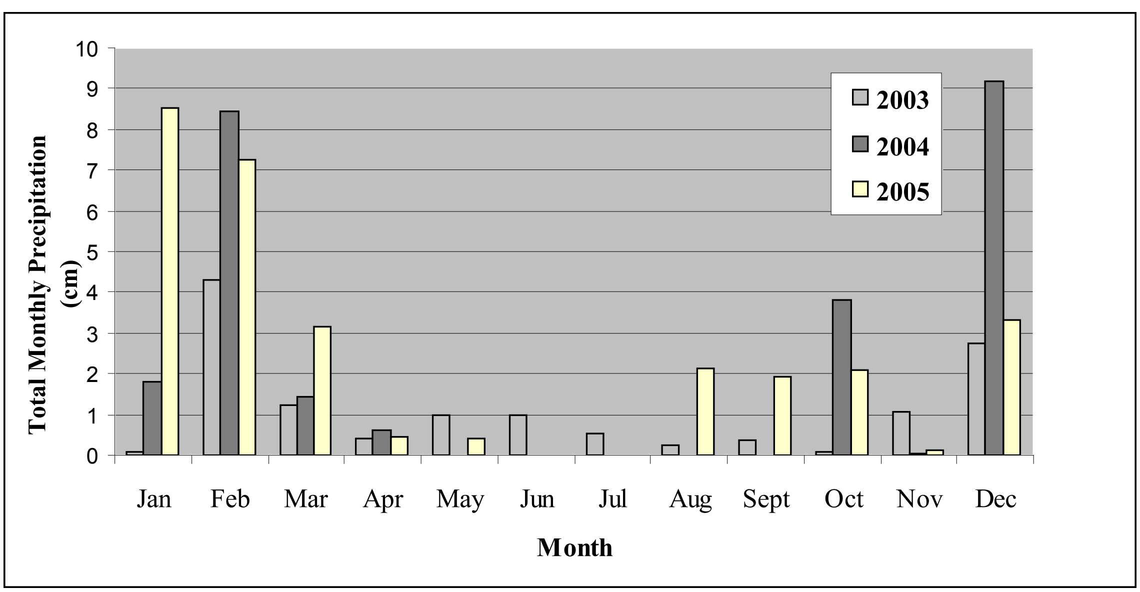

Figure 1. Monthly precipitation (cm) totals for the Indian Wells Valley, California from 2003–2005.

Table 1. Schnabel-Eschmeyer population estimates (N ± SE), confidence interval (CI), and density estimates (#/ha) of white-tailed antelope ground squirrels at ten sampling locations in the Indian Wells Valley, California (2006).

	Session 1			Session 2		
	N ± SE	CI	#/ha	*N* ± SE	CI	#/ha
Grid 1	47±0.002	38 – 59	5.33	59±0.001	49 – 73	6.69
Grid 2*	48±0.002	39 – 61	5.44	113±0.001	93 – 146	12.81
Grid 3	39±0.002	33 – 48	4.42	49±0.005	29 – 152	5.55
Grid 4*	15±0.004	14 – 16	1.70	86±0.002	62 – 143	9.75
Grid 5	43±0.004	30 – 75	4.88	36±0.003	27 – 54	4.08
Grid 6	69±0.002	47 – 127	7.82	106±0.001	95 – 119	12.02
Grid 7*	27±0.005	20 – 44	3.06	85±0.003	20 – 289	9.64
Grid 8	64±0.003	43 – 127	7.26	33±0.002	28 – 42	3.74
Grid 9	79±0.002	50 – 185	8.96	27±0.018	11 – 72	3.06
Grid 10	42±0.004	30 – 71	4.76	63±0.003	43 – 119	7.14
Mean	47±0.0002	34 – 69	5.36	66±0.0003	49 – 121	7.45

* significant at $P < 0.05$

Chi-squared tests resulted in significantly increased density at Grid 2 and Grid 4 and significantly decreased density at Grid 7 from early to late spring (Table 1).

Discussion

We calculated adult white-tailed antelope squirrel densities for 10 sampling locations in the IWV during two sampling sessions (15 March – 30 April and 1 May to 30 May, 2006). Populations estimates were calculated using the Schumacher-Eschmeyer closed population model and ranged from 15–79 squirrels/grid ($\bar{x} = 47$) in early spring and 27–113 squirrels/grid ($\bar{x} = 66$) in late spring. The mean adult white-tailed antelope squirrel density for early spring was 5.36 squirrels/ha (range 1.7–8.96 squirrels/ha), with a mean adult density in late spring of 7.45 squirrels/ha (range 3.06–12.81 squirrels/ha). Adult white-tailed antelope squirrel densities in the IWV during early and late spring were 89 and 124 times greater, respectively, than previously reported densities in southern Nevada (Blackbush dominant habitat, Bradley 1964) of 0.06 squirrels/ha (Bradley 1967).

We identified two interlinked factors potentially explaining adult white-tailed antelope squirrel density differences between the IWV and Bradley (1967): precipitation and habitat. We obtained long-term precipitation values for the Desert Game Range, Nevada, where Bradley (1967) conducted his study. Mean precipitation for the Desert Game Range from 1961–1990 was 11.28 cm annually, with the highest monthly precipitation totals reported during Bradley's (1964) study period (WRCC 2009). Mean annual precipitation in the IWV was 185% (range 6.6–241%) above average from 2003–2005 (WRCC 2007) likely increasing forage availability for adult white-tailed antelope squirrels during our study as compared to Bradley (1967). Precipitation has been shown to affect net primary production of plant communities and is especially true in desert ecosystems (Chew and Chew 1965, Whitford 2002). Above average precipitation in the IWV when compared to average precipitation at the Desert Game Range likely increased ecosystem functioning and net primary production in the IWV which in turn could have increased white-tailed antelope squirrel over-winter survival and fecundity (Reichman and van de Graaf 1975, Reynolds and Turkowski 1972).

Management Implications

We found short-term seasonal shifts in adult white-tailed antelope squirrel densities in the Indian Wells Valley and speculate shifts were related to forage availability. Seasonal changes in home range patterns are a common occurrence to utilize available forage. Further studies of seasonal shifts by white-tailed antelope squirrels are necessary to determine the extent of these shifts and evaluate potential management strategies which may affect white-tailed antelope squirrel populations.

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